Answer Key – MODERN PHYSICS R-REVIEW PACKET

UTHERBCKD	MATTER WAVES	COMPTON EFFECT	WAVE-PARTICLE DUALITY
1. 1	1) 4	1) 4	1) 4
2. 4	2) 2	2) 4	2) 3
3. 4	3) 1	3) 2	3) 1
4. 3	4) 3	4) 3	4) 1
5. 3	5) 4	5) 2	5) 1
6. 1	6) 2	6) 1	
7. 1	7) 4		
8. 4			
9. 3			
10. 3			
11. 3			
12. ~~4~~			
13. 1			

Answer Key – MODERN PHYSICS REVIEW PACKET

RUTHERFORD

1. 1
2. 4
3. 4
4. 3
5. 3
6. 1
7. 1
8. 4
9. 3
10. 3
11. 3
12. ~~4~~
13. 1

MATTER WAVES

1) 4
2) 2
3) 1
4) 3
5) 4
6) 2
7) 4

COMPTON EFFECT

1) 4
2) 4
3) 2
4) 3
5) 2
6) 1

WAVE-PARTICLE DUALITY

1) 4
2) 3
3) 1
4) 1
5) 1

Matter Waves (DeBroglie'sEquation)

1. All of the following particles are traveling at the same speed. Which has the greatest wavelength?
   (1) proton (3) neutron
   (2) alpha particle (4) electron

2. If the wave properties of a particle are difficult to observe, it is probably due to the particle's
   (1) small size (3) low momentum
   (2) large mass (4) high charge

3. According to the theory of matter waves, as the momentum of a particle increases, its wavelength
   (1) decreases (3) remains the same
   (2) increases

4. What is the wavelength of the matter wave associated with a bird of 1.0-kilogram mass flying at 2.0 meters per second?
   (1) 3.3×10^{34} m (3) 3.3×10^{-34}m
   (2) 1.3×10^{-33} m (4) 8.6×10^{-34} m

5. The concept that electrons exhibit wave properties can best be demonstrated by the
   (1) emission of photoelectrons
   (2) scattering of alpha particles by electrons
   (3) collisions between photons and electrons
   (4) production of electron interference patterns

6. Which of the following would best illustrate the wave properties of matter?
   (1) photoelectric effect (3) alpha particle scattering
   (2) diffraction of electrons (4) photon-particle collisions

7. A mass m moving with a velocity v has a wavelength of
   (1) h x $+mv$Ý (3) h x mv
   (2) h/($\frac{1}{2}mv^2$) (4) h/mv

Compton Effect

1. In a photon-electron collision, there is conservation of
   (1) mass (3) momentum, only
   (2) energy, only (4) energy and momentum

2. Which is conserved when a photon collides with an electron?
   (1) velocity (3) energy, only
   (2) momentum, only (4) momentum and energy

3. As a photon loses energy during a collision, its wavelength
   (1) decreases (3) remains the same
   (2) increases

4. An x-ray photon collides with an electron in an atom, ejecting the electron and mitting another photon. During the collision, there is conservation of
   (1) momentum, only
   (2) energy, only
   (3) both momentum and energy
   (4) neither momentum nor energy

5. As the frequency of a photon increases, its momentum
   (1) decreases (3) remains the same
   (2) increases

6. Compared to the photon momentum of blue light the photon momentum of red light is
   (1) less (3) the same
   (2) greater

Wave-Partic Duality

1. The photon model of light is more appropriate than the wave mode explaining
   (1) interference (3) polarization
   (2) refraction (4) photoelectric emission

2. Light demonstrates the characteristics of
   (1) particles, only (3) both particles and waves
   (2) waves, only (4) neither particles nor waves

3. Interference and diffraction can be explained by
   (1) the wave theory, only
   (2) the particle theory, only
   (3) neither the wave nor particle theory

4. Which phenomenon can be explained by both the particle model a wave model?
   (1) reflection (3) diffraction
   (2) polarization (4) interference

5. Which phenomenon can best be explained by the wave model of li rather than the particle model of light?
   (1) interference (3) energy transfer
   (2) reflection (4) refraction

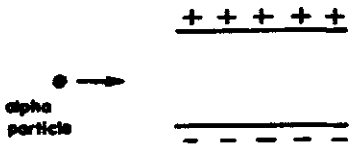
Rutherford

1. In the Rutherford scattering experiment, gold foil was bombarded by
   (1) alpha particles (3) electrons
   (2) protons (4) neutrons

2. What is an alpha particle?
   (1) an electron (3) a deuteron
   (2) a hydrogen nucleus (4) a helium nucleus

3. The mass number of an alpha particle is
   (1) 1 (3) 3
   (2) 2 (4) 4

4. A moving alpha particle enters the space between two oppositely charged plates as indicated in the diagram below.



Which arrow best represents the path of the alpha particle as it travels between the plates?

(1)
(3) 
(2) 
(4) 

5. The fact that most of the alpha particles directed at a thin metal foil pass through without being deflected indicates that the atom consists mostly of
   (1) electrons (3) empty space
   (2) neutrons (4) protons

6. In Rutherford's scattering experiments with thin metal foil, most of the alpha particles were deflected through very small angles. This indicated that the atomic nucleus is
   (1) very small in size (3) negatively charged
   (2) positively charged (4) neutral

Base your answers for questions 7 through 8 on Rutherford's experiments in which alpha particles were allowed to pass into a thin gold foil. All alpha particles had the same speed.

7. The paths of the scattered alpha particles were
   (1) hyperbolic (3) parabolic
   (2) circular (4) elliptical

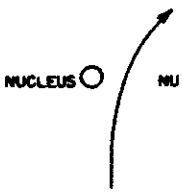
8. Some of the alpha particles were deflected. The explanation for this phenomenon is that
   (1) electrons have a small mass
   (2) electrons have a small charge
   (3) the gold leaf was only a few atoms thick
   (4) the nuclear charge and mass are concentrated in a small volume

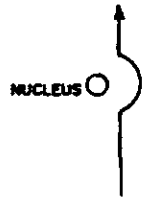
9. In alpha particle scattering, the nucleus produces an effect on the scattering angles. This is primarily due to the fact that the nucleus
   (1) has a small total charge
   (2) has a mass close to that of the alpha particles
   (3) exerts coulomb forces
   (4) is widely dispersed throughout the atom

10. When alpha particles are scattered by thin metal foils, which observation indicates a very high percentage of space in atoms?
   (1) Thicker foils scatter more.
   (2) The paths are hyperbolic.
   (3) Most pass through with little or no deflection.
   (4) The scattering angle is related to the atomic number.

11. Which diagram best represents the path of an alpha particle as it passes near the nucleus of an atom?

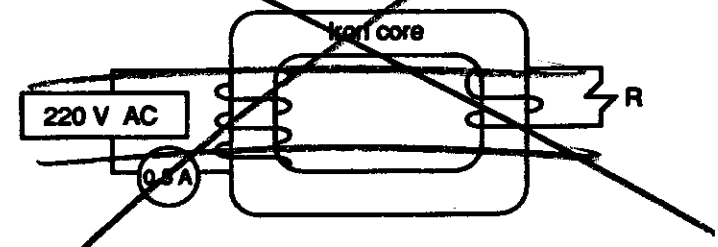
(1) 

(3) 

(2) 

(4) 

12. Base your answer on the diagram below represents a 100% efficiency device connected to an alternating current source of 220 volts. The primary coil has 50 turns and the secondary coil has 25 turns. When the device operates, a 0.50-ampere current flows through the primary.



What is the potential difference across resistor R in the secondary cell?
(1) 110 V (3) 440 V
(2) 220 V (4) 2800 V

13. A model of the atom in which the electrons can exist only in specified orbits was suggested by
   (1) Bohr (3) Einstein
   (2) Planck (4) Rutherford

Photons

1. What is the energy of a photon with a frequency of 3.00×10^{13} cycles per second?

(1) 2.21×10^{-48} J (3) 6.63×10^{-34} J

(2) 2.21×10^{-46} J (4) 1.99×10^{-20} J

2. Base your answer on the information below.

Monochromatic light strikes a metal surface that has a work function of 6.7×10^{-19} joule. Each photon has an energy of 8.0×10^{-19} joule.

What is the energy of each photon expressed in electron-volts?

(1) 5.4×10^{-37} eV (3) 8.0×10^{-19} eV

(2) 1.6×10^{-19} eV (4) 5.0 eV

3. The energy of a photon varies
(1) directly as the wavelength
(2) directly as the frequency
(3) inversely as the frequency
(4) inversely as the square of the frequency

4. Which formula may be used to compute the energy of a photon?

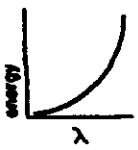
(1) $E = hf$ (3) $E = \frac{1}{2}mv^2$

(2) $E = mg\Delta h$ (4) $E = FS$

5. Which graph best represents the relationship between the energy of a photon and its wavelength?

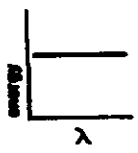
(1)

(3)



(2)

(4)



6. An atom changing from an energy state of –0.54 eV to an energy state of –0.85 eV will emit a photon whose energy is

(1) 0.31 eV (3) 0.85 eV

(2) 0.54 eV (4) 1.39 eV

7. When incident on a given photoemissive surface, which color of light will produce photoelectrons with the greatest energy?

(1) red (3) violet

(2) orange (4) green

8. The wavelength of photon *A* is greater than that of photon *B*. Compared to the energy of photon *A*, the energy of photon *B* is

(1) less (3) the same

(2) greater

9. According to the quantum theory of light, the energy of light is carried in discrete units called

(1) alpha particles (3) photons

(2) protons (4) photoelectrons

10. Which color light has photons of the greatest energy?

(1) red (3) green

(2) yellow (4) blue

11. Which transmits the energy in a light beam?

(1) electrons (3) protons

(2) photons (4) neutrons

12. Which color of light has the greatest energy per photon?

(1) red (3) blue

(2) green (4) violet

Modern Physics Test

Name:_____

1. The photon model of light is more appropriate than the wave model in explaining
   (1) interference (3) polarization
   (2) refraction (4) photoelectric emission

2. Interference and diffraction can be explained by
   (1) the wave theory, only
   (2) the particle theory, only
   (3) neither the wave nor particle theory

3. Which phenomenon can best be explained by the wave model of light rather than the particle model of light?
   (1) interference (3) energy transfer
   (2) reflection (4) refraction

4. Base your answer on the information below:

   Incident photons with an energy of 6.0×10^{-19} joule per photon cause electrons to be ejected from a surface. The work function of the surface is 3.0×10^{-19} joule.

   Compared to the original incident photons, photons with a higher energy would have a
   (1) longer wavelength (3) higher frequency
   (2) higher intensity (4) greater speed

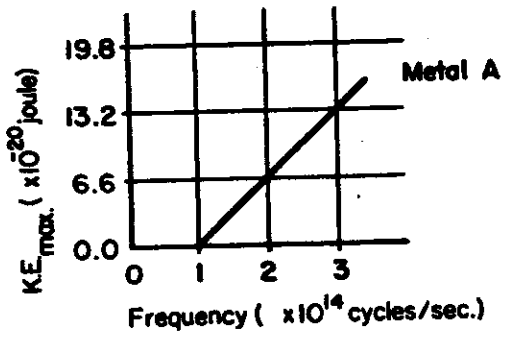
5. When incident on a given photoemissive surface, which color of light will produce photoelectrons with the greatest energy?
   (1) red (3) violet
   (2) orange (4) green

6. An atom changing from an energy state of –0.54 eV to an energy state of –0.85 eV will emit a photon whose energy is
   (1) 0.31 eV (3) 0.85 eV
   (2) 0.54 eV (4) 1.39 eV

7. The wavelength of photon *A* is greater than that of photon *B*. Compared to the energy of photon *A*, the energy of photon *B* is
   (1) less (3) the same
   (2) greater

8. What is the energy of a photon with a frequency of 5.0×10^{15} hertz?
   (1) 3.3×10^{-18} J (3) 1.5×10^{24} J
   (2) 2.0×10^{-16} J (4) 7.5×10^{48} J

Base your answers for questions **9** through **12** on the graph below that represents the maximum kinetic energy of the photoelectrons emitted by a metal surface upon exposure to a beam of light of varying frequency.



9. The work function for metal *A* is
   (1) 0.0 J (3) 6.6×10^{-34} J
   (2) 6.6×10^{-20} J (4) 6.6×10^{-48} J

10. As the frequency of the light falling on metal *A* increases above the threshold frequency, the maximum kinetic energy of the photoelectrons
    (1) decreases (3) remains the same
    (2) increases

11. The slope of the line for metal *A* is
    (1) 6.6 J-s (3) 6.6×10^{-20} J-s
    (2) 6.6×10^{-6} J-s. (4) 6.6×10^{-34} J-s

12. Metal *B* with a work function of 2.0×10^{-19} joule is substituted for metal *A*. If photons with an energy of 6.0×10^{-19} joule are incident on the surface of metal *B*, the kinetic energy of the emitted photoelectrons will be
    (1) 12.0×10^{-19} J (3) 3.0×10^{-19} J
    (2) 2.0×10^{-19} J (4) 4.0×10^{-19} J

Atomic Energy Levels

1. What is the energy of the emitted photon when a hydrogen atom changes from an energy state of $n = 5$ to $n = 4$?
   (1) 13.06 eV (3) 0.54 eV
   (2) 1.39 eV (4) 0.31 eV

2. A hydrogen atom undergoes a transition from the $n = 4$ state to the $n = 1$ state. The energy of the single photon emitted during the transition is approximately
   (1) 13.6 eV (3) 2.55 eV
   (2) 12.75 eV (4) 0.85 eV

3. Which photon energy could be absorbed by a hydrogen atom that is in the $n = 2$ state?
   (1) 1.51 eV (3) 2.1 eV
   (2) 1.89 eV (4) 2.4 eV

4. If a hydrogen atom absorbs 1.9 eV of energy, it could be excited from energy level
   (1) $n = 1$ to $n = 2$ (3) $n = 2$ to $n = 3$
   (2) $n = 1$ to $n = 3$ (4) $n = 2$ to $n = 4$

5. A photon having an energy of 15.5 electron volts is incident upon a hydrogen atom in the ground state. If the photon is absorbed by the atom, it will
   (1) ionize the atom (3) excite the atom to $n = 3$
   (2) excite the atom to $n = 2$ (4) excite the atom to $n = 4$

6. A photon emitted from an excited hydrogen atom has an energy of 3.02 electronvolts. Which electron energy-level transition would produce this photon?
   (1) $n = 1$ to $n = 6$ (3) $n = 6$ to $n = 1$
   (2) $n = 2$ to $n = 6$ (4) $n = 6$ to $n = 2$

7. A hydrogen atom could have an electron energy-level transition from $n = 2$ to $n = 3$ by absorbing a photon having an energy of
   (1) 1.51 eV (3) 4.91 eV
   (2) 1.89 eV (4) 10.20 eV

8. An excited hydrogen atom returns to its ground state. A possible energy change for the atom is a
   (1) loss of 10.20 eV (3) loss of 3.40 eV
   (2) gain of 10.20 eV (4) gain of 3.40 eV

9. A hydrogen atom emits blue light when it changes from the $n = 4$ energy level to the $n = 2$ energy level. Which color of light would the atom emit when it changes from the $n = 5$ level to the $n = 2$ level?
   (1) red (3) green
   (2) yellow (4) violet

10. As excited an excited electrons in hydrogen atoms return to the ground state, they emit
    (1) electrons (3) photons
    (2) protons (4) neutrons

11. Several hydrogen atoms are supplied with sufficient energy to excite them to the $n = 3$ energy level. As the atoms return to the ground state, how many different energy-level transitions are possible?
    (1) 1 (3) 3
    (2) 2 (4) 4

12. Compared to the amount of energy required to excite an atom, the amount of energy released by the atom when it returns to the ground state is
    (1) less (3) the same
    (2) greater

13. Which phenomenon provides evidence that the hydrogen atom has discrete energy levels?
    (1) emission spectra (3) alpha particle scattering
    (2) photoelectric effect (4) natural radioactive decay

14. An excited atom emits a photon of energy E when an electron changes from energy level $n = 3$ to $n = 2$. In order for the same electron to change directly from energy level $n = 2$ to $n = 3$, it may
    (1) absorb a photon with energy E
    (2) absorb a photon with energy 2E
    (3) emit a photon with energy 3E
    (4) emit a photon with energy E/2